Update on the status of the RHIC polarimeter analysis

Contents

- About offline analysis
- Understanding of the existing systematic
- Stability of the beam polarization

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Our interests and tasks

- ## Interests
  - Fully understand the systematic of the polarimeter results
  - Confirm if any depolarization during the long store exists
  - -t dependence of the asymmetry
        and cross sections (slope) ($\leftarrow$not contained in this talk)

- ## Tasks
  - Distributions of asymmetry values by version control
    - Including several offline corrections
      - Energy scale, Energy loss correction
      - Excluding bad strips, etc.
  - Systematic study
    - Understanding of the false asymmetries
      - Some measurements have the
        discrepancy X90 $\leftrightarrow$ X45
        Y components in Yellow ring (1/18/02~)
    - Stability of the polarization during the stores

What is available in our data set for offline analysis

Energy (keV)

independent

Bunch # (1-55)
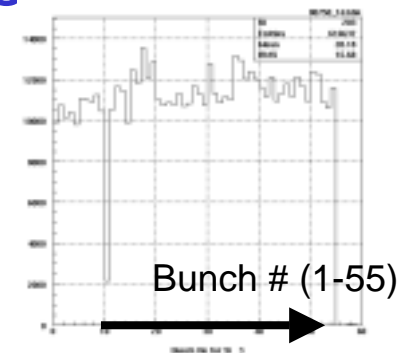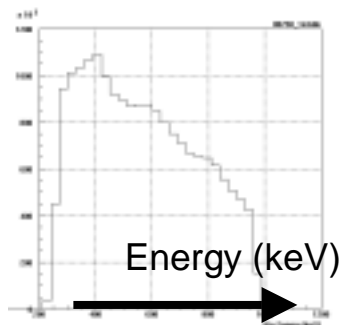
Spin sorted ADC histogram for each strip (1-72)
- Up (+)
- Down (-)
- 0-pol

Bunch dist. histogram for each strip (1-72)
With spin bit pattern from V124

- Energy loss correction
  (Target & dead layer)
- Energy scale correction
- Strip selection

- Bunch by bunch polarization
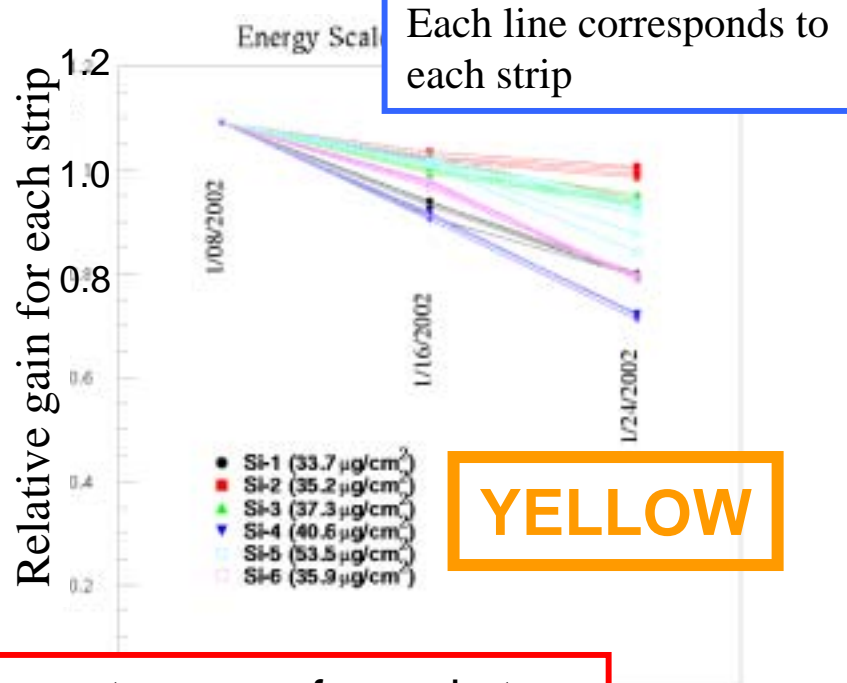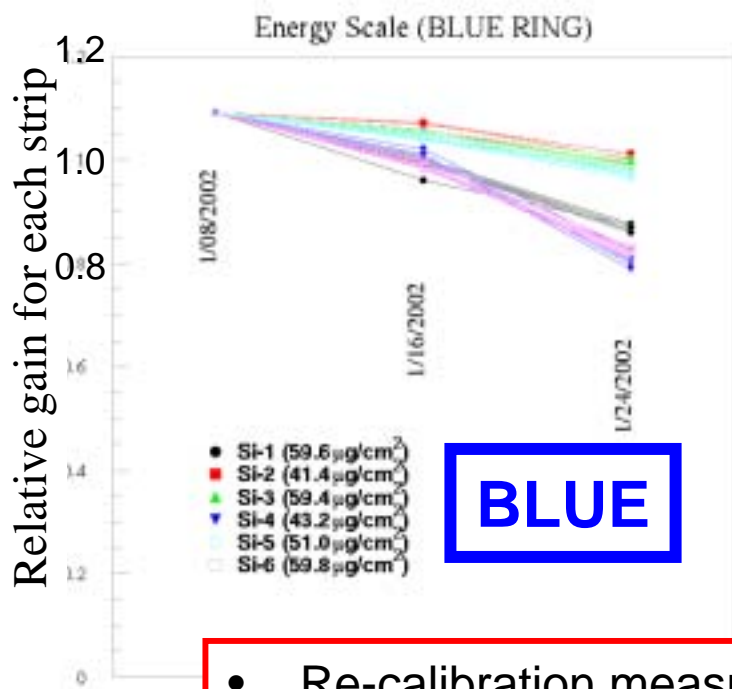- Strip selection
- Bunch selection

Already distributed asymmetry info

- Several versions of the asymmetry values have been revised and distributed in the form of spread sheets
- The analysis is basically based on the spin sorted energy spectrums, where the re-definition of the energy cut is capable
- Providing many kinds of run conditions
- Assign the flag for validity of the each measurement
- Current situation

-t range is defined as

Analyzing power Ver 2.0 (by J. Tojo)

Ver 1.0 (distributed)

target+dead layer correction

Ver 1.1 (ready but not announced)

energy scale correction

http://spin.riken.bnl.gov/exp/pcpol

Energy scale corrections

Energy Scale (BLUE RING)

Relative gain for each strip

1.2, 1.0, 0.8

1/08/2002 1/16/2002 1/24/2002

- Si-1 (59.6 μg/cm²)
- Si-2 (41.4 μg/cm²)
- Si-3 (59.4 μg/cm²)
- Si-4 (43.2 μg/cm²)
- Si-5 (51.0 μg/cm²)
- Si-6 (59.8 μg/cm²)

BLUE

Energy Scale

Relative gain for each strip

1.2, 1.0, 0.8

1/08/2002 1/16/2002 1/24/2002

- Si-1 (33.7 μg/cm²)
- Si-2 (35.2 μg/cm²)
- Si-3 (37.3 μg/cm²)
- Si-4 (40.6 μg/cm²)
- Si-5 (53.5 μg/cm²)
- Si-6 (35.9 μg/cm²)

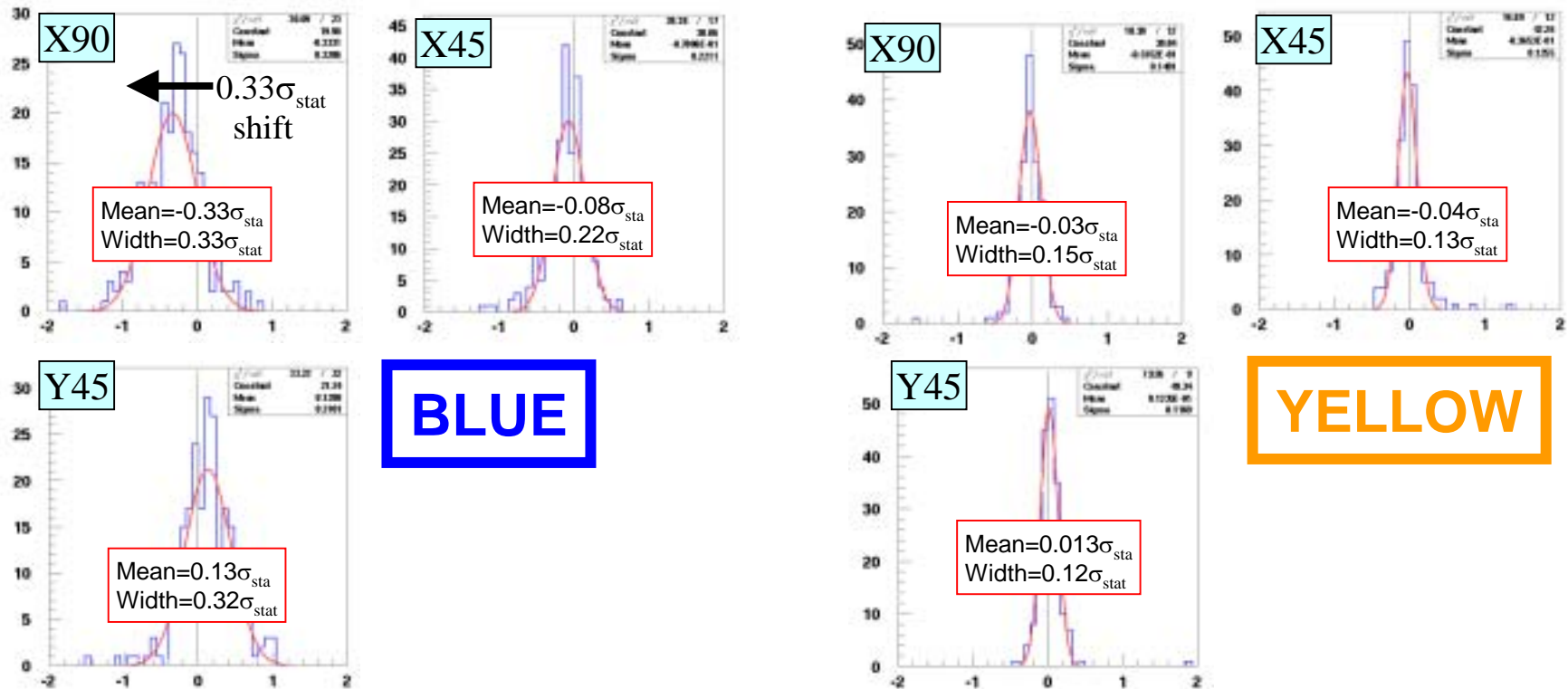**YELLOW**

Each line corresponds to each strip

- Re-calibration measurements are performed at 1/8, 1/16 and 1/24(run end)
- Strips from same detector behave in like wise
- No correlation with the dead layer thickness
- The corrections are made with linear interpolation for each strip after the first recalibration
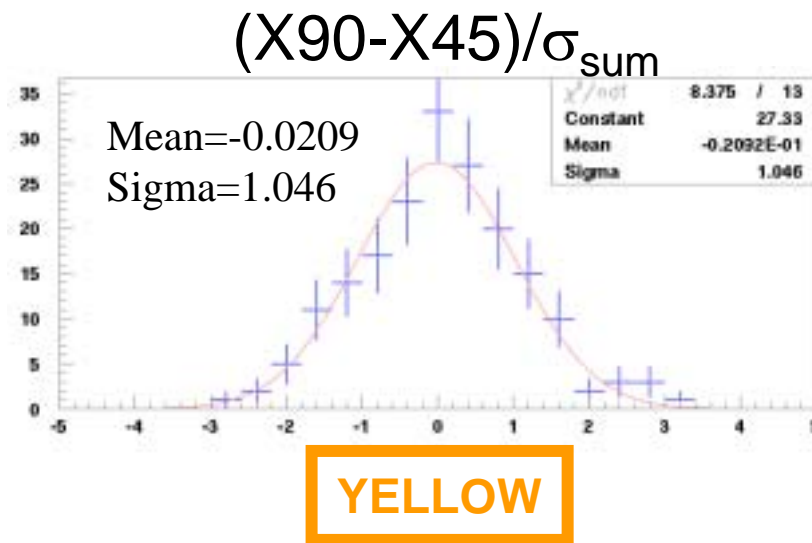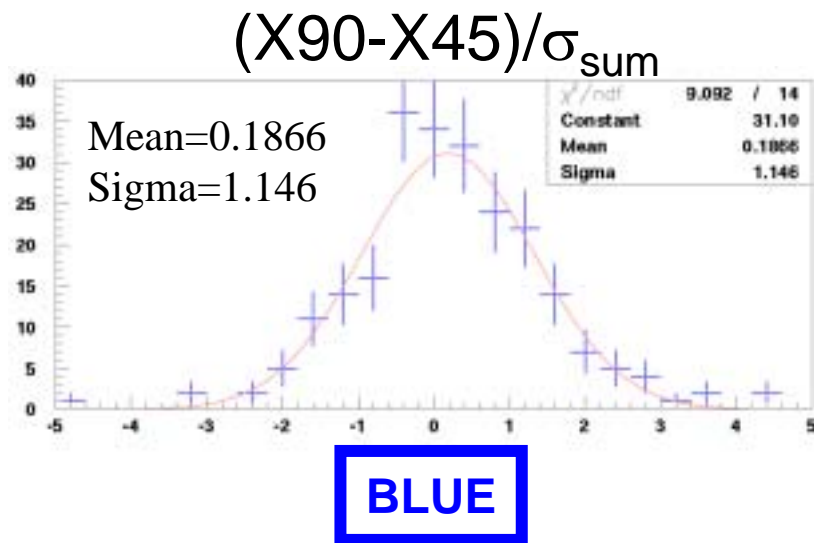
Results after the corrections
(energy loss & energy scale)

X90

← $0.33\sigma_{stat}$ shift

Mean=$-0.33\sigma_{sta}$
Width=$0.33\sigma_{stat}$

X45

Mean=$-0.08\sigma_{sta}$
Width=$0.22\sigma_{stat}$

X90

Mean=$-0.03\sigma_{sta}$
Width=$0.15\sigma_{stat}$

X45

Mean=$-0.04\sigma_{sta}$
Width=$0.13\sigma_{stat}$

Y45

Mean=$0.13\sigma_{sta}$
Width=$0.32\sigma_{stat}$

BLUE

Y45

Mean=$0.013\sigma_{sta}$
Width=$0.12\sigma_{stat}$

YELLOW

(After-Before)/σ_{stat} plots

- Deviations stemming from the corrections are symmetric and well below the statistical error bars, except blue X90 which has been slightly shifted

Significance of the X90,X45 separation

$(X90-X45)/\sigma_{sum}$

Mean=0.1866
Sigma=1.146

χ^2/ndf	9.092 / 14
Constant	31.10
Mean	0.1866
Sigma	1.146

BLUE

$(X90-X45)/\sigma_{sum}$

Mean=-0.0209
Sigma=1.046

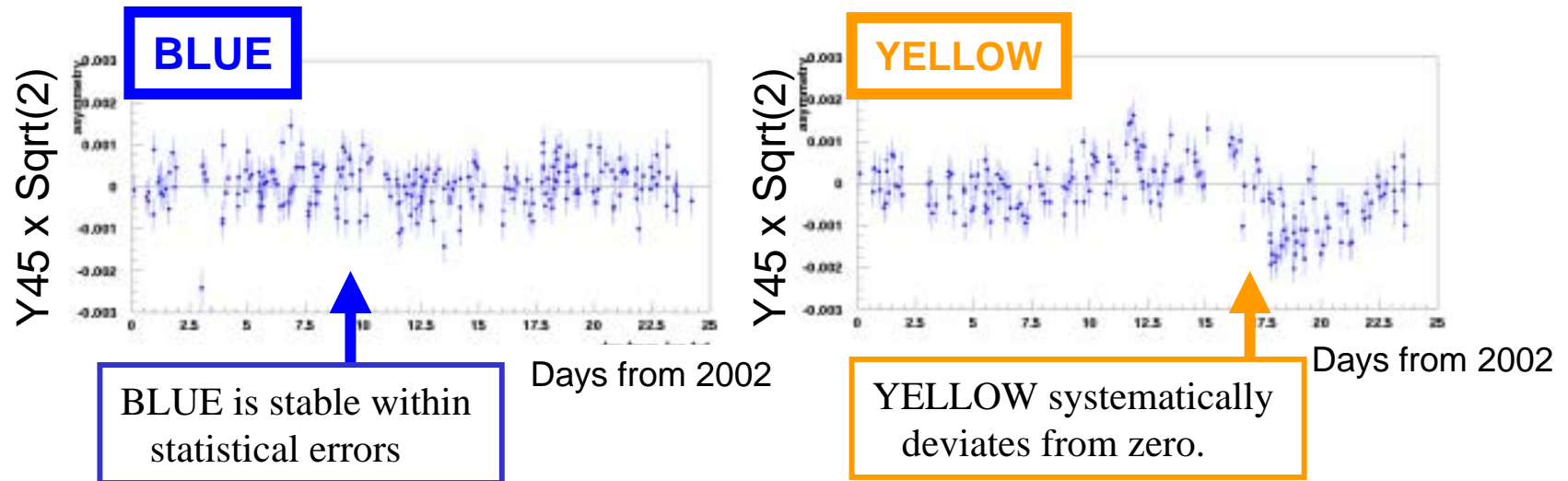| χ^2/ndf	8.375 / 13
Constant	27.33
Mean	-0.2092E-01
Sigma	1.046

YELLOW

- The degree of separation is in good agreement with the statistical fluctuation of the measurements
- At the level of statistics that we have, the statistical errors still dominate over the systematic
- The average of X90 and X45 (equivalently Xlsq) **can be considered trustworthy**

$$\sigma_{sum} = \sqrt{\sigma^2_{X90stat} + \sigma^2_{X45stat}}$$

Used data set 1/1-1/24

Still remaining Y components

BLUE

Y45 x Sqrt(2)

Days from 2002

BLUE is stable within statistical errors

YELLOW

Y45 x Sqrt(2)

Days from 2002

YELLOW systematically deviates from zero.

- The energy corrections has not improved the Y-components anomalies in yellow
- The study starting from the bunch distribution histograms are on going. Comparison with WCM (wall current monitor) is also shows a quite interesting feature, though no conclusion was delivered so far.

Polarization stability during the store

Physics Asymmetry (1/22/02)
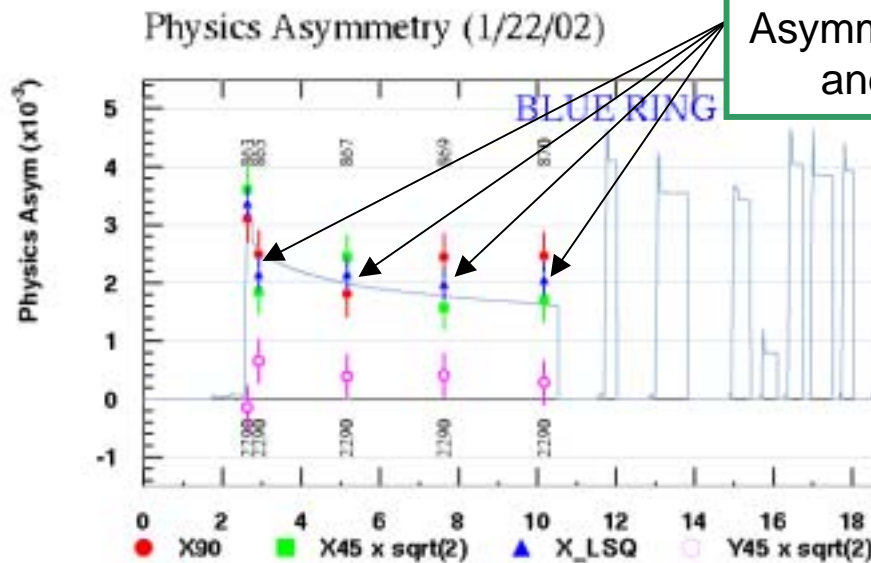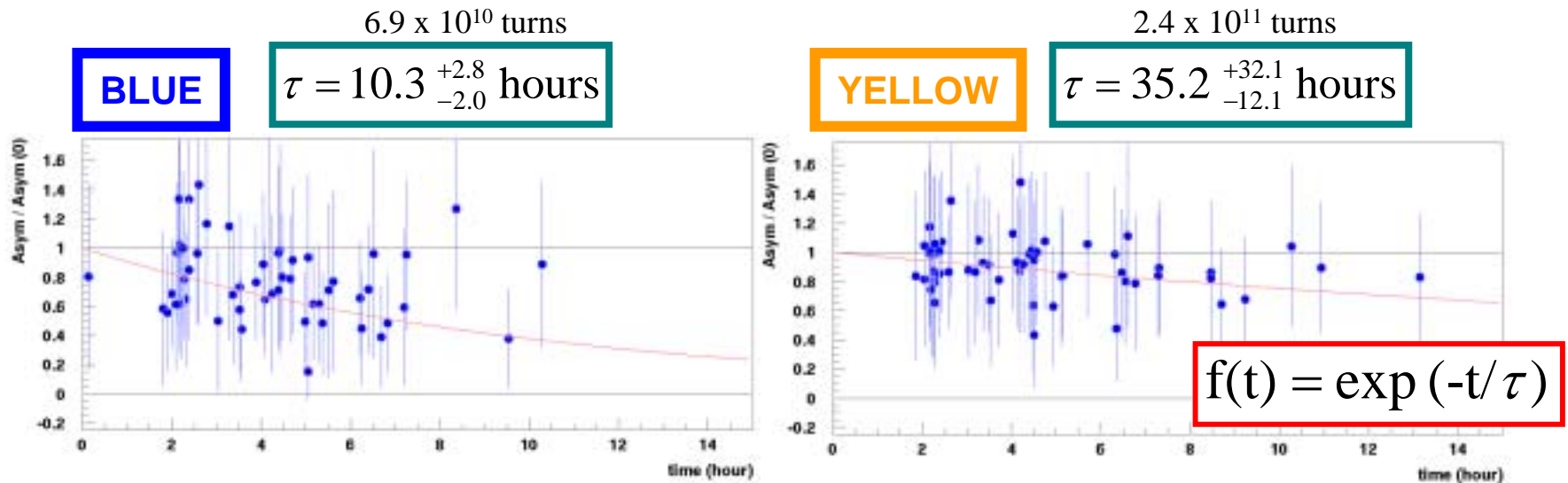
Asymmetry A[0],A[1],,,
and beam intensity B[0],B[1],,,

To see the tendency, the values
are normalized as A[n] / A[0]

Used fill ID
2147,2153,2161,2162,2173,
2175,2178,2181,2185,2187,
2201,2208,2212,2233,2244,
2246,2251,2258,2266,2269,
2275,2277,2281,2290,2301

- Choose the fill which satisfies following conditions
    - There is a measurement immediately after the ramp
    - Store > 4 hours
    - 1st measurement has asymmetry > 1.0×10^{-3}
    - The data after Jan. 4th
- Taking the ratio against the 1st measurement
- Is there any correlation with beam intensity ?

Asymmetry as a function of store time

6.9×10^{10} turns

BLUE

$$\tau = 10.3 \, ^{+2.8}_{-2.0} \text{ hours}$$

2.4×10^{11} turns

YELLOW

$$\tau = 35.2 \, ^{+32.1}_{-12.1} \text{ hours}$$

$$f(t) = \exp(-t/\tau)$$

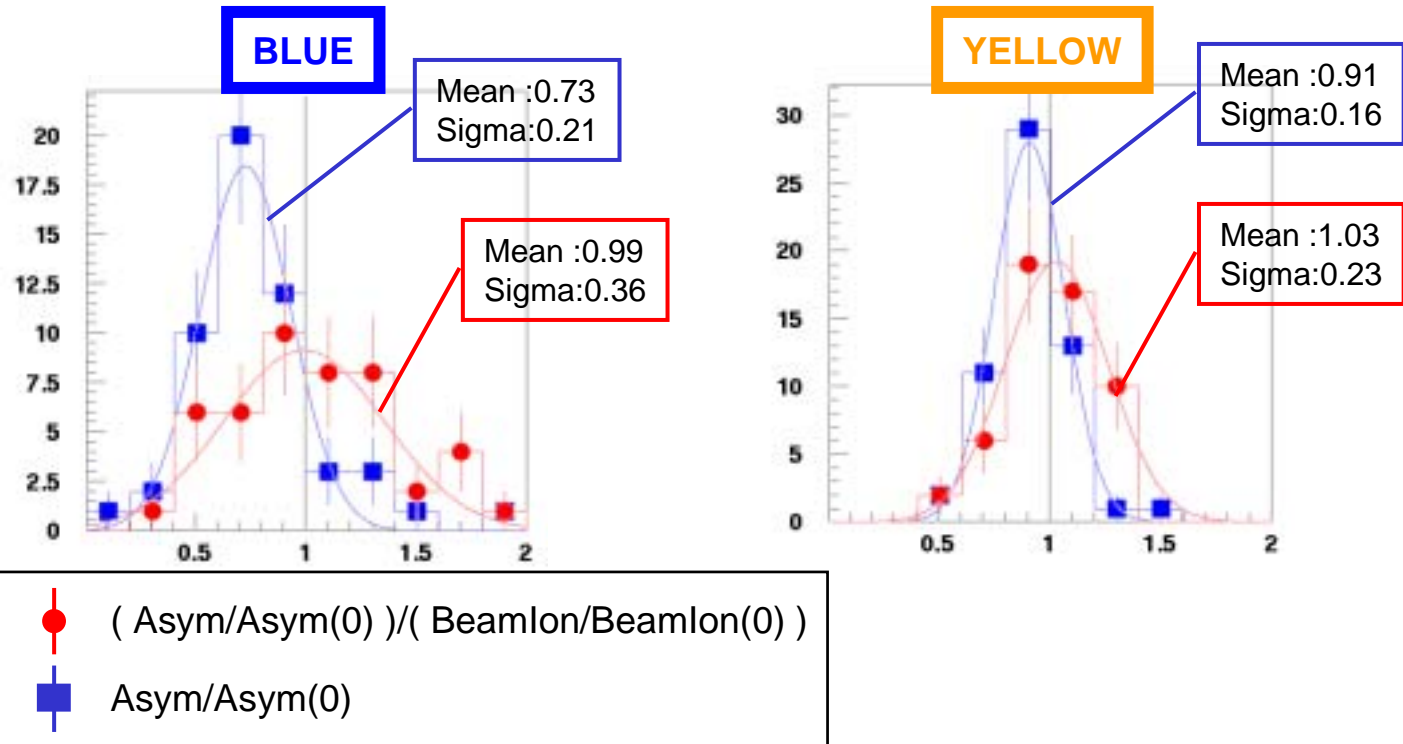Time starting from the first measurement at flattop (hour)

- We assume the exponential decay function from unit=1 at time=0 although we do not have any particular reason
- Using Xlsq values (asymmetry value calculated with fit)
- Exponential curves fit well, showing long lifetime in yellow, while blue has rather short lifetime
- Statistically, they are depolarizing during the store

Asymmetry .vs. beam intensity
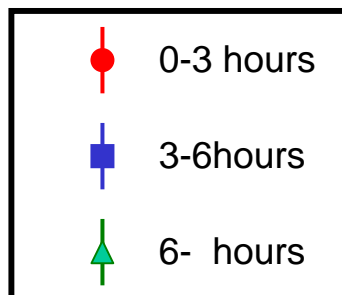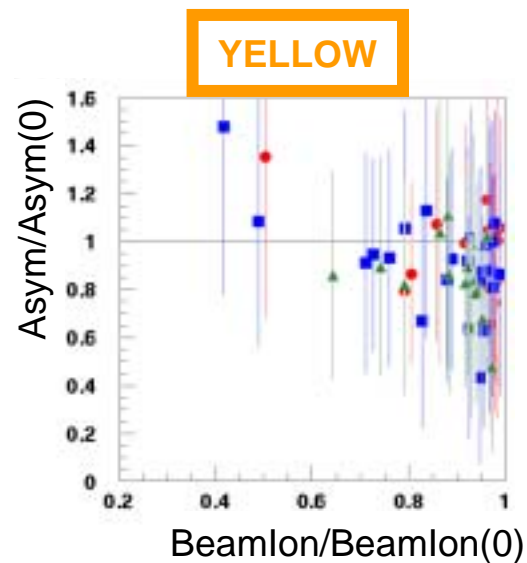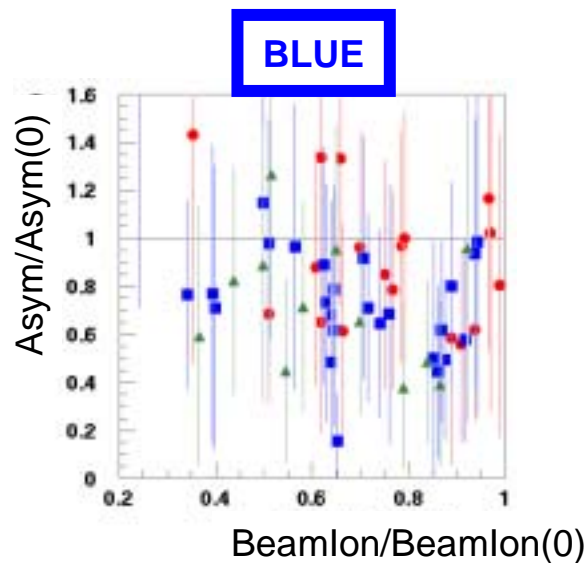
BLUE

YELLOW

- The correlation between the lifetime of the asymmetry and beam intensity is not clear due to the large statistical error bars
- However by comparing blue and yellow, the correspondence is found, i.e.

  asymmetry decays ←→

               beam intensity decays

Asymmetry .vs. beam intensity (2)

BLUE

Mean :0.73
Sigma:0.21

Mean :0.99
Sigma:0.36

YELLOW

Mean :0.91
Sigma:0.16

Mean :1.03
Sigma:0.23

- ● (Asym/Asym(0))/(BeamIon/BeamIon(0))

- ■ Asym/Asym(0)

- By taking the ratio, the distributions show the peak structures around 1 with larger width on both ring
- Statistically, the decay of the asymmetry and the decay of the beam intensity behave in similar way

Remaining tasks

Needless to say, there are so many….

- On going study for Y-component anomalies
- Bunch by bunch polarization study
  - Using 10 successive runs (with 0 pol bits) taken at polarimeter dedicated run time
  - The polarizations of the plus and negative spin bit bunches are equal ?
- Estimation of the systematic error originating
  from the false spin bit pattern
- Polarimeter dedicated run data with WFD AT mode
  - -t dependent asymmetry with x8 good energy resolution
  - Cross section (slope) study
  - Detailed study on the WFD signal shape
- …….

Summary and Outlook

- ## Systematic study
  - Separation between X90 and X45 looks reasonable within a statistical error bar
  - Y-component anomalies are still under study

- ## Stability of the asymmetry during the same fill
  - The asymmetry has the lifetime
    - Blue : 10.3 hour Yellow:35 hour

- ## Several measurements are needed for more precise determinations?
  - Current statistics (20Mevents) corresponds to about 5% error for 0.004 asymmetry